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8 The Broad Scope of Free Innovation

To date, empirical studies of free user innovation have focused almost entirely on product innovations. However, free innovation logically should extend far beyond products. After all, the test for innovation opportunity viability presented in chapter 3 has nothing to say about the nature of specific opportunities. It just specifies that innovators' expected benefits should exceed their expected costs.

In this chapter, I show that the scope of free innovation in the household sector is indeed broad—and perhaps as broad as that of producer innovation with respect to products, services, and processes of interest to consumers. I do this by reviewing the findings of field-specific studies and by discussing illustrative examples of the sources of innovation across five innovation categories used in official OECD government statistics.

Types of Innovations

To test for the ubiquity of free innovation, I use the definition of innovation used by government statistical agencies in OECD nations. "*An **innovation** is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*" (*Oslo Manual* 2005, paragraph 146, italics in original). Adjusting that producer-centric language to include the possibility of free innovators, we see that it refers to five innovation subject matters: An innovation is a new or significantly improved (1) product, (2) service, (3) process, (4) marketing method, or (5) organizational method related to free or producer innovation practices or external relations.

In the sections that follow, I briefly document the presence of free innovation in the household sector with respect to Oslo Manual

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categories 2-5. The importance of free innovation activity in category (1), products, has already been documented in earlier sections of this book.

Free user innovation in services

Uniform governmental statistics on services are collected under nine high-level categories: wholesale and retail trade; hotels and restaurants; transport, storage, and communication; financial intermediation; real estate, renting, and business activities; public administration and defense; education; health and social work; and other community, social, and personal service activities (UN 2002). Services are of great economic significance. Taken together, all services make up a portion of GDP that is roughly twice as large as that of all products.

There are two main attributes that distinguish services from products. In the case of a service, (1) production and consumption cannot be separated and therefore (2) one cannot keep a service in inventory (Fitzsimmons and Fitzsimmons 2001; Zeithaml and Bitner 2003; Vargo and Lusch 2004; Crespi, Criscuolo, Haskel, and Hawkes 2006). In contrast, one can do both of these things in the case of a product. For example, a producer can build a taxi and put it into inventory to await a buyer. A taxi is a product, and production and consumption of products can be separated. However, a taxi *ride* is a service, and so a provider cannot similarly offer, available for purchase, an inventory of completed rides from your workplace to your home. Alas, one must patiently sit in the cab, consuming a ride exactly when and as it is produced. The same is true of medical services. Again, and again alas, one cannot purchase a completed medical operation; one must consume it as it is produced.

Services are often thought of as necessarily involving a provider and a consumer (Vargo and Lusch 2004). For example, a taxi service involves both a driver and a passenger, the passenger receiving the transportation service and taxi driver (or self-driving taxi) providing it. But it is also true that a passenger can drive himself or herself—that is, self-provide a similar transportation service. When consumers *can* "serve themselves," it is also possible for them to innovate with respect to the services they deliver to themselves. Just as in the case of products, these

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services may then diffuse to peers as DIY self-services, and also may diffuse to producers for commercialization.

In subsections that follow, I will summarize the findings of three empirical studies of the sources of innovation in three types of services: retail banking, mobile banking, and medicine. As will be seen, service innovation development by free innovators is prominent in all three.

Free user development of retail banking services Oliveira and I studied the sources of commercially important services in retail banking (Oliveira and von Hippel 2011). The sample consisted of all basic types of retail banking services offered by major banks in 2011 within the traditional range of "core" banking services, such as loans, checking accounts, savings accounts, and time deposits. Services offered beyond that range, such as brokerage and insurance services, were excluded. Within the core banking services, we focused on innovations that had been first commercialized by retail banks between 1975 and 2010.

During the period Oliveira and I studied, banks were introducing new services in computerized rather than manual forms. For many of the sixteen major retail banking services first commercialized between 1975 and 2010, however, there had been earlier manual ways to perform the essentially the same services. To understand the full innovation history, we therefore sought to identify both the developers of the first computerized version of each service in our sample, and also the developers of the manual precursors to those services where that information could be found.

Table 8.1
Sources of important retail banking services.

Service type	*n*	free user	bank	joint
Developers of manual precursor services	10	80%	0%	20%
Developers of first computerized versions	16	44%	56%	0%

Source: Oliveira and von Hippel 2011, tables 3 and 4

As can be seen in table 8.1, my colleague and I determined that 80 percent of the manual precursors for the basic types of computerized

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services offered by major banks today were developed by household sector users who had personal uses for those innovations. User innovators also developed of 44 percent of the first computerized versions of those services. As best we could tell from searches of the literature and from interviews of experts, all were free innovations, not protected by intellectual property rights, and available for free adoption. As an example of a basic service for which both the manual practice and the first computerized version were developed through free innovation by users, consider "account information aggregation." The need for that service arises because many retail banking customers deal with multiple banks or other financial institutions at the same time. For example, your checking and savings accounts might be with one bank, your home mortgage may be serviced by another, and your credit card accounts may be serviced by still other banks. Somehow, financial information from all these institutions must be "aggregated" so that you can see and manage your overall financial situation.

Until 1999 each bank reported to each customer only its own financial dealings with that customer. Customers then aggregated multiple reports from multiple banks for themselves, using their own methods, and so were the initial developers and users of manual versions of "account information aggregation." Individuals also were the first to develop the computerized version of this service in the basic form that was eventually commercialized by banks. Consider this individual's personal innovation history:

> I do my banking online, but I quickly get bored with having to go to my bank's site, log in, navigate around to my accounts, and check the balance on each of them. One quick Perl module (Finance::Bank::HSBC) later, I can loop through each of my accounts and print their balances, all from a shell prompt. With some more code, I can do something the bank's site doesn't ordinarily let me do: I can treat my accounts as a whole instead of as individual accounts, and find out how much money I have, could possibly spend and owe, all in total. Another step forward would be to schedule a cron entry (Hack#90) every day to use the HSBC option to download a copy of my transactions in Quicken's QIF format, and use Simon Cozens' *Finance::QIF* module to interpret the file and run those transaction against a budget, letting me know whether I'm spending too much lately. This takes a simple web-based system from being merely useful to being automated and bespoke; if you can think of how to write the code, you can do it. (Hemenway and Calishain 2004, 62)

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The computerized information aggregation service now offered commercially by banks functions in essentially the same way as this individual's version. With an account owner's permission, a bank automatically contacts each financial institution with which a retail user has an account, logs on with the user's password, collects information on the status of each account, and logs off. It then assembles the information collected from all accounts into a spreadsheet tailored to the user's specifications.

Free user development of mobile banking services Mobile phone banking is based upon a technically very sophisticated cell phone platform. Despite this, the platform offers novel service possibilities that can be discovered by individuals who do not understand its technical details. (By analogy, innovators can and do develop important new uses for airplanes, e.g., carrying the mail or spotting forest fires, without having to know in any technical detail how an airplane actually functions.) Van der Boor, Oliveira, and Veloso (2014) examined the histories of a complete list of the twenty basic mobile financial services reported by Groupe Speciale Mobile Association (GSMA). They found that 85 percent of these innovations originated in countries with relatively poor conventional retail banking service infrastructures, where the need was high. They also found that 45 percent were first developed by household sector users. Cell phone service providers developed 45 percent, and 5 percent were developed by users and producers jointly. One (5 percent) was developed by a firm with a business use for the innovation.

As a typical innovation history, consider the development of a method for transferring money—a basic mobile banking service—by cell phone users in the Philippines. In the Philippines, customers could pay for their cell phone use by means of "scratch cards" sold at retail stores. After buying a scratch card of a certain denomination, the purchaser was instructed to scratch an obscuring layer from the surface of the card to reveal a unique multi-digit activation code. When typed into the phone, that code transferred prepaid cell phone credit to that customer's phone number.

In 1998, customers in the Philippines recognized that they could also use scratch card codes for a fundamentally different purpose.

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Instead of adding minutes ("airtime") to their own phones, they could transfer the credit codes to others as an acceptable substitute for cash. To accomplish this, the purchaser of a scratch card, instead of entering the activation code revealed on the card into his own phone, would send the unique activation code by text messaging to a person to whom he wished to transfer money. That person could then use the paid-for airtime, or pass the credit along further as he or she chose. As a second basic service, individual users subsequently pioneered the use of airtime as a form of currency for merchant payments. Five years later, in 2003, cell phone service producers began to offer commercial versions of these banking services, which by then were already in widespread consumer use (van der Boor, Oliveira, and Veloso 2014). All of these user-developed novel services were unprotected and freely shared, and thus meet the criteria for free innovations.

Free user development of medical services for patients with rare diseases There are between 5,000 and 8,000 rare diseases that, taken together, afflict approximately 8 percent of the world's population (Rodwell and Aymé 2014; Committee for Orphan Medicinal Products and European Medicines Agency Scientific Secretariat 2011). Many of these diseases are chronic and impose significant difficulties on the daily lives of both patients and their caregivers (Song, Gao, Inagaki, Kukudo, and Tang 2012). Small market size, due to the low prevalence of each disease, makes it commercially unattractive for pharmaceutical firms and other medical suppliers to invest in development of new products and services specifically for a rare disease (Acemoglu and Linn 2004). As a consequence, patients with rare diseases tend to be underserved both clinically and commercially (Griggs, Batshaw, Dunkle, Gopal-Srivastava, Kaye, Krischer, Nguyen, Paulus, and Merkel 2009).

Because patients with rare diseases are often underserved, colleagues and I speculated that they would often decide to innovate to help themselves. To explore this idea, we conducted a survey on that topic among 500 afflicted medical patients in Portugal, using a questionnaire quite similar to the one used in the national surveys described in chapter 2. We found that there was a great deal of self-help innovation among patients with rare diseases and their non-professional caregivers. Of 500 respondents, 36 percent reported

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developing something they viewed as novel. They also reported on average that their innovations significantly aided them in dealing with their disease and improving their quality of life. Almost all of the innovations were medical services rather than devices. After application of the novelty screening criteria used in the national surveys of product innovation described in chapter 2, 8 percent of respondents (40 of 500 respondents) were found to have developed innovations that were judged by expert medical evaluators to be new to medical practice (Oliveira, Zejnilovic, Canhão, and von Hippel 2015).

As an illustration of a patient-developed service innovation novel to medicine, consider a development by Joaquina Teixeira, the mother of a child with Angelman's Syndrome, a rare genetic disorder. One attribute of Angelman's Syndrome is ataxia, an inability to walk, move, or balance well. Young children with that disability understandably do not want to practice standing and walking and, unless energetic interventions are applied, will not do so. Professional medical advice to parents is simply to "make your child stand and walk often." In practice, following this advice leads to many unhappy interactions between determined parents and reluctant children.

Joaquina Teixeira, who was struggling with exactly that problem, noticed that her son, when at a neighbor child's birthday party, kept reaching for colorful helium balloons that were floating in the party room, high above his head and out of reach. She promptly went and bought 100 helium balloons and released them in a room in her own home. As he had done at the party, her son kept reaching for the strings of the balloons. Teixeira carefully set these strings to a length that he could reach only by standing. He was thus motivated to repeatedly attempt to stand without prompting. His mother constantly varied the challenges, the child never tired of the game, and his standing and walking skills improved greatly. This medical service innovation is easily replicable and was freely revealed by the developer, both in person and via the Internet, to assist other parents and children in the same situation (Teixeira 2014).

Free user development of process equipment: 3D printers

Like commercial producers, free innovators use production processes to create personal copies of the innovations they develop. These

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production processes must be quite inexpensive to be within the personal means of individual innovators in the household sector. Production equipment made for producers is often quite costly, and so it is reasonable that free user innovators would attempt to develop less costly production process innovations and improvements for themselves.

Consider the development of personal 3D printers—fabrication machines that use design information encoded in software to "print" physical objects. The major role of free user innovators in the innovation history of this field has been reported by de Bruijn (2010) and by de Jong and de Bruijn (2013).

The innovation history of the 3D printer field (often called additive manufacturing) began in 1981 when Hideo Kodama of Nagoya Municipal Industrial Research Institute invented fabrication methods that built up a three-dimensional object from successive layers of a polymer hardened by exposure to ultraviolet light. Other researchers followed, developing alternative methods of "3D printing," and in 1984 commercial production of 3D printers began. The first commercial machines were quite expensive, costing about $250,000 each. They were marketed to research institutions and to the R&D departments of firms, and were used for rapid fabrication of product prototypes. The time savings over conventional prototype fabrication techniques made the machines quite cost-effective for producers in that application.

In 2004, Adrian Bowyer, a senior lecturer in mechanical engineering at the University of Bath, proposed the development of a rapid prototyping machine that he called RepRap (meaning Replicating Rapid prototyper). Bowyer wanted to design a 3D printer that would be very simple, cheap, and at least partially self-replicating (in the sense that one printer could print many of the parts needed to make additional printers). After his initial proposal, development commenced at the University. The evolving design was openly shared online and soon captured the interest of a widely distributed audience of free innovators who joined the design effort and pooled their contributions. Fewer than ten people were involved in the first year, but interest grew rapidly. By October of 2010, the online hobbyist 3D printer community had grown to between 4,000 and 5,000 participants (de Bruijn 2010, 19, 31).

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De Bruijn surveyed 376 members of this online community to determine, among other things, how much time members were spending on various activities related to their hobby. On average, he found, they were spending 10.41 hours working with or developing their personal 3D printing machines per week. That time was distributed into the several activity categories shown in table 8.2. As can be seen, developing improvements to the personal 3D printer—either to print what an individual user wanted or just to make the machine better—accounted for 15 percent of the time devoted by household sector users to activities related to 3D printers. Many important improvements resulted, and all were shared openly. The developers in the online community were free innovators intentionally following open source software community practices (de Jong and de Bruijn 2013).

Table 8.2
Time, per week, spent by the average individual on using and improving a personal 3D printer.

	Hours	Percentage of time
Building the machine	4.9	47%
Printing objects	1.7	16%
Developing improvements	1.5	15%
Helping other users	0.9	9%
Improving skills	1.4	13%
Total	10.4	100%

Source: de Bruijn 2010, table 4.3

Free user development of a "marketing method": community brands

Although free innovators give their innovations away rather than sell them, they can still be interested in marketing methods for a number of reasons. Innovation communities may, for example, wish to advertise for contributors to join their efforts. According to Dahlander (2007, 930), "at times of stiff competition between communities, attracting a base of users and developers is not easy." In addition, they may wish to increase the diffusion of their innovations, motivated by one or more of the various forms of self-reward I discussed in chapter 5.

One example of innovation in marketing methods by free innovators is the use of everyday activities to generate powerful brands at no

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incremental cost. A brand is a "name, term, sign, symbol, or design, or a combination of them intended to identify the goods and services of one seller or group of sellers and to differentiate them from those of competition" (Kotler 1997, 443). In legal terms, a brand is a trademark. Brands and marketing methods are typically associated with sellers, as in Kotler's definition. However, it is clear that the functions of a brand with respect to identifying the developer of an innovation and that innovators' reputation for quality would be useful to potential adopters of free innovations as well.

Studies show that open source software development communities generate their own powerful brands at no cost by simply creating and displaying a logo or a trademark with which people associate positive experiences both within and outside the community. How does this work? Consider that the general mechanism behind the strengthening and the shaping of brands involves linking similar positive associations to brand names or symbols within the minds of many potential customers (Edwards 1990; Zajonc 1968; Keller 1993). If the effort required to embed mental associations in the minds of many is undertaken for that special purpose and is expensive as in the case of many producers' marketing campaigns— it is not cheap to hire a famous athlete to pose at the top of a mountain holding a branded can of soda—the creation of a brand will be expensive. If, however, the stimulus for a broadly shared mental association arises as a side effect of activities or experiences undertaken for other purposes, brand creation can be costless.

Collaborative free innovation projects often adopt names and logos to demark their projects (for example, the Apache feather, the Linux penguin). As a consequence, community contributors will have the shared experience of working on innovations and interacting with like-minded others with a clear association to the community's logo and name. In the course of their activities, they gain rich positive experiences that are associated with the community and that contain elements similar to those experienced by other community members. The resulting shared mental associations, gained as a byproduct of common activities, should function to costlessly create and strengthen a brand.

In work reported by Füller, Schroll, and von Hippel (2013), two colleagues and I tested this idea by conducting an empirical study of

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brand strength of Apache and Microsoft Web server software. We found that Apache was the stronger brand both within the Apache community and outside it with respect to that type of software. Interviews with Apache Foundation leaders documented that there was no investment made by Apache to specifically to create or strengthen the Apache brand. This is not a single-case phenomenon, nor is it restricted to open source software. Pitt, Watson, Berthon, Wynn, and Zinkhan (2006) note that the open source movement has produced a series of well-known brands, including Linux and Mozilla Firefox. More generally, Cova and White (2010) term communities that create their own brands "alter-brand" communities.

New organizational methods

Finally, we come to the *Oslo Manual*'s inclusion within official innovation statistics of "*a new organizational method in business practices, workplace organization or external relations*" (*Oslo Manual* 2005, paragraph 146). Individuals acting within the free innovation paradigm have developed many novel ways to work together as unpaid innovators and to collaborate in developing and diffusing innovations. I am not aware of any systematic studies of this particular category of free user innovation, but there are many examples. Participants in open source software projects have been especially active in developing new methods of working together (von Krogh, Spaeth, and Lakhani 2003; O'Mahony and Ferraro 2007; O'Mahony 2007).

As one important example, consider the General Public License, invented by Richard Stallman (2002). In 1985 Stallman, a brilliant programmer in MIT's Artificial Intelligence Laboratory, set about developing and diffusing a legal mechanism that could preserve free access to the software developed by software "hackers." Stallman's innovative idea was to use the existing mechanism of copyright law to that end. Software authors interested in preserving the status of their software as "free" could use their own copyright to grant licenses on terms that would guarantee a number of rights to all future users and innovators. They could do this by simply affixing to their software a standard license that conveyed those rights.

The basic license that Stallman developed to implement that idea was the General Public License (GPL), sometimes referred to as

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"copyleft." Basic rights transferred to those possessing a copy of free software include the right to use it at no cost, the right to study its source code, the right to modify it, and the right to distribute modified or unmodified versions to others at no cost. Licenses conveying similar rights were developed by others, and a number of such licenses are currently in use. The GPL is a fundamental "organizational method" innovation, developed for the free and open source software field but containing novel ideas and principles that are widely applicable (Torrance 2010; Torrance and Kahl 2014).

As a second example of an important organizational innovation developed by free innovators, consider distributed revision control packages, which are widely used in software development today. Initially created by open source software project developers to manage their own projects, the currently most popular version of such software is GIT, which was initially developed by Linus Torvalds for Linux kernel development in 2005, and which has since been further developed by many others. GIT has spread to many other open source software projects and to many other types of applications via hosting services such as GitHub.com (Ram 2013). GIT makes it possible for all contributors to collaborative efforts to work asynchronously and to merge their contributions at any time. Tools commonly available within GIT and other software packages support the tracing of errors and the maintenance of a full audit trial of past versions. Version control software is an important organizational innovation. Developed by free innovators for their own use within collaborative projects, the principles are widely applicable beyond the organization and management of open source software projects.

Discussion

At the start of this chapter, I argued that innovation opportunities viable for user innovators are likely to extend to many types of innovation in addition to product development. That seemed reasonable because there is nothing in the definition of a viable innovation opportunity that restricts free innovators to product innovation or any other specific kind of innovation (Baldwin and von Hippel 2011). And indeed, we now see that free innovation in the household sector is present

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within all five basic innovation categories currently measured in OECD nations' innovation statistics (*Oslo Manual* 2005, paragraph 146).

I conclude, from these early empirical findings, that free innovation is likely to be an important contributor to innovative advances across the entire spectrum of innovation opportunities of interest to individuals in the household sector. This is a very valuable result with respect to improving our understanding of the importance of free innovation, and with respect to learning to both measure and utilize it more effectively.

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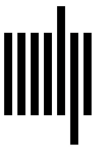

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